

CLAIMS

1. Tire comprising at least one structural element including a crosslinked elastomeric material obtained by crosslinking a crosslinkable elastomeric composition comprising:
- 5 (a) 100 phr of at least one diene elastomeric polymer;
- (b) from 1 phr to 50 phr of at least one layered material having an individual layer thickness
- 10 of from 0.01 nm to 30 nm;
- (c) from 0.1 phr to 15 phr of at least one methylene donor compound;
- (d) from 0.4 phr to 20 phr of at least one methylene acceptor compound.
- 15 2. Tire according to claim 1, wherein said crosslinkable elastomeric composition comprises from 2 phr to 40 phr, preferably from 5 phr to 30 phr, of at least one layered material (b).
- 20 3. Tire according to claim 1 or 2, wherein said at least one layered material (b) has an individual layer thickness of from 0.05 nm to 15 nm.
4. Tire according to any one of the preceding claims, wherein said crosslinkable elastomeric composition comprises from 0.3 phr to 10 phr of at least one methylene donor compound (c).
- 25 5. Tire according to any one of the preceding claims, wherein said crosslinkable elastomeric composition comprises from 0.8 phr to 15 phr of at least one methylene acceptor compound (d).
- 30 6. Tire according to claim 1, comprising:
- a carcass structure of a substantially toroidal shape, having opposite lateral edges associated with respective right-hand and left-hand bead structures, said bead structures comprising at
- 35 least one bead core and at least one bead filler;

- a belt structure applied in a radially external position with respect to said carcass structure;
  - a tread band radially superimposed on said belt structure;
  - a pair of sidewalls applied laterally on opposite sides with respect to said carcass structure;
  - at least one structural element selected from bead filler, sidewall insert, tread underlayer, tread base, obtained by crosslinking a crosslinkable elastomeric composition comprising:
    - (a) 100 phr of at least one diene elastomeric polymer;
    - (b) from 1 phr to 50 phr of at least one layered material having an individual layer thickness of from 0.01 nm to 30 nm;
    - (c) from 0.1 phr to 15 phr of at least one methylene donor compound;
    - (d) from 0.4 phr to 20 phr at least one methylene acceptor compound.
7. Tire according to claim 6, wherein said crosslinkable elastomeric composition comprises from 2 phr to 40 phr, preferably from 5 phr to 30 phr, of at least one layered material (b).
8. Tire according to claim 6 or 7, wherein said at least one layered material has an individual layer thickness of from 0.05 nm to 15 nm.
9. Tire according to any one of claims 6 to 8, wherein said crosslinkable elastomeric composition comprises from 0.3 phr to 10 phr of at least one methylene donor compound (c).
10. Tire according to any one of claims 6 to 9, wherein said crosslinkable elastomeric composition comprises from 0.8 phr to 15 phr of at least one

methylene acceptor compound (d).

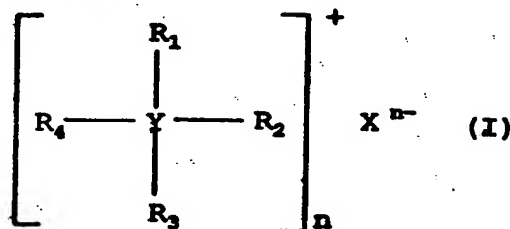
11. Tire according to any one of claims 6 to 10, wherein said sidewall insert extends radially from a position corresponding to the bead structure to a position corresponding to a tread lateral edge.
12. Tire according to any one of claims 6 to 11, wherein said tread underlayer is a layer of crosslinked elastomeric composition applied in a radially internal position with respect to said tread band.
13. Tire according to any one of claims 6 to 12, wherein said tread band is of cap and base construction and comprises a radially inner layer or tread base and a radially outer layer or tread cap.
14. Tire according to any one of the preceding claims, wherein said structural element has a dynamic elastic modulus ( $E'$ ), measured at 70°C, not lower than 5 MPa.
15. Tire according to claim 14, wherein said structural element has a dynamic elastic modulus ( $E'$ ), measured at 70°C, of from 8 MPa to 80 MPa.
16. Tire according to any one of the preceding claims, wherein said structural element has a tensile modulus at 100% elongation (100% Modulus) not lower than 3 MPa.
17. Tire according to claim 16, wherein said structural element has a tensile modulus at 100% elongation (100% Modulus) of from 4 MPa to 20 MPa.
18. Tire according to any one of the preceding claims, wherein said structural element has a IRHD hardness, measured at 23°C, not lower than 65.
19. Tire according to claim 18, wherein said structural element has a IRHD hardness, measured at 23°C, of from 70 to 95.
20. Tire according to any one of the preceding claims,

wherein the diene elastomeric polymer (a) has a glass transition temperature below 20°C.

21. Tire according to claim 20, wherein the diene elastomeric polymer (a) is selected from: natural or synthetic cis-1,4-polyisoprene, 3,4-polyisoprene, polybutadiene, optionally halogenated isoprene/isobutene copolymers, 1,3-butadiene/acrylonitrile copolymers, styrene/1,3-butadiene copolymers, styrene/isoprene/1,3-butadiene copolymers, styrene/1,3-butadiene/acrylonitrile copolymers, or mixtures thereof.
22. Tire according to any one of the preceding claims, wherein the crosslinkable elastomeric composition comprises at least 10% by weight with respect to the total weight of the at least one diene elastomeric polymer (a) of natural or synthetic cis-1,4-polyisoprene.
23. Tire according to claim 22, wherein the crosslinkable elastomeric composition comprises from 20% by weight to 100% by weight with respect to the total weight of the at least one diene elastomeric polymer (a) of natural or synthetic cis-1,4-polyisoprene.
24. Tire according to any one of the preceding claims, wherein the crosslinkable elastomeric composition further comprises at least one elastomeric polymer of one or more monoolefins with an olefinic comonomer or derivatives thereof (a').
25. Tire according to claim 24, wherein the elastomeric polymer (a') is selected from: ethylene/propylene copolymers (EPR) or ethylene/propylene/diene copolymers (EPDM); polyisobutene; butyl rubbers; halobutyl rubbers; or mixtures thereof.
26. Tire according to any one of claims 20 to 25, wherein the diene elastomeric polymer (a) or the

elastomeric polymer (a') include at least one functional group selected from carboxylic groups, carboxylate groups, anhydride groups, ester groups, epoxy groups.

- 5 27. Tire according to any one of the preceding claim, wherein said layered material (b) is selected from phyllosilicates such as: smectites such as, montmorillonite, bentonite, nontronite, beidellite, volkonskoite, laponite, hectorite, saponite, 10 sauconite, magadite, kenyasite, stevensite; vermiculite; halloisite; sericite; aluminate oxides; hydrotalcite; or mixtures thereof.
28. Tire according to claim 27, wherein said layered material (b) is montmorillonite.
- 15 29. Tire according to any one of the preceding claims, wherein said layered material (b) is treated with a compatibilizing agent.
- 20 30. Tire according to claim 29, wherein said compatibilizing agent is selected from the quaternary ammonium or phosphonium salts having general formula (I):



wherein:

- Y represents N or P;
- 25 -  $R_1$ ,  $R_2$ ,  $R_3$  and  $R_4$ , which may be identical or different, represent a linear or branched  $C_1$ - $C_{20}$  alkyl or hydroxyalkyl group; a linear or branched  $C_1$ - $C_{20}$  alkenyl or hydroxyalkenyl group; a group  $-R_5-SH$  or  $-R_5-NH$  wherein  $R_5$  30 represents a linear or branched  $C_1$ - $C_{20}$  alkylene group; a  $C_6$ - $C_{18}$  aryl group; a  $C_7$ - $C_{20}$  arylalkyl or

alkylaryl group; a C<sub>5</sub>-C<sub>18</sub> cycloalkyl group, said cycloalkyl group possibly containing hetero atom such as oxygen, nitrogen or sulfur;

- X<sup>an</sup> represents an anion such as the chlorine ion, the sulphate ion or the phosphate ion;

- n represents 1, 2 or 3.

- 5 31. Tire according to any one of the preceding claims, wherein the methylene donor compound (c) is selected from: hexamethylenetetramine (HMT);
- 10 hexamethoxymethylmelamine (HMMM); formaldehyde; paraformaldehyde; trioxane; 2-methyl-2-nitro-1-propanal; substituted melamine resins such as N-substituted oxymethylmelamine resins; glycoluril compounds such as tetramethoxymethyl glycoluril;
- 15 urea-formaldehyde resins such as butylated urea-formaldehyde resins; or mixtures thereof.
32. Tire according to claim 31, wherein the methylene donor compound (c) is hexamethylenetetramine (HMT) or hexamethoxymethylmelamine (HMMM).
- 20 33. Tire according to any one of the preceding claims, wherein the methylene acceptor compound (d) is selected from: resorcinol; catechol; hydroquinone; pyrogallol; phloroglucinol; 1-naphthol; 2-naphthol; phenolic resins obtained from the condensation of
- 25 an optionally substituted phenol with an aldehyde such as formaldehyde, acetaldehyde, furfural; or mixtures thereof.
34. Tire according to claim 33, wherein the methylene acceptor compound (d) is resorcinol.
- 30 35. Tire according to any one of the preceding claims, wherein said methylene donor compound (c) and said methylene acceptor compound (d) are added to the crosslinkable elastomeric composition in the precondensed form
- 35 36. Tire according to any one of the preceding claims, wherein said crosslinkable elastomeric composition

comprises from 0 phr to 120 phr of (e) at least one carbon black reinforcing filler.

37. Tire according to claim 36, wherein said crosslinkable elastomeric composition comprises from 20 phr to 90 phr of (e) at least one carbon black reinforcing filler.
38. Tire according to any one of the preceding claims, wherein said crosslinkable elastomeric composition comprises (f) at least one silane coupling agent.
39. Tire according to claim 38, wherein said silane coupling agent (f) is selected from those having at least one hydrolizable silane group which may be identified by the following general formula (II):
- $$(R)_3Si-C_nH_{2n}-X \text{ (II)}$$
- wherein the groups R, which may be identical or different, are selected from: alkyl, alkoxy or aryloxy groups or from halogen atoms, on condition that at least one of the groups R is an alkoxy or aryloxy group; n is an integer of from 1 to 6 inclusive; X is a group selected from: nitroso, mercapto, amino, epoxide, vinyl, imide, chloro,  $-(S)_mC_nH_{2n}-Si-(R)_3$  or  $-S-COR$  in which m and n are integers of from 1 to 6 inclusive and the groups R are defined as above.
40. Tire according to claim 38 or 39, wherein said silane coupling agent (f) is present in the crosslinkable elastomeric composition in an amount of from 0 phr to 10 phr.
41. Tire according to claim 40, wherein said silane coupling agent (f) is present in the crosslinkable elastomeric composition in an amount of from 0.5 phr to 5 phr.
42. Tire according to any one of the preceding claims, wherein said crosslinkable elastomeric composition comprises discontinuous fibres (g).
43. Tire according to claim 42, wherein said

- discontinuous fibres (g) are aramid fibres.
44. Tire according to claim 43, wherein said aramid fibres are short fibrillated poly(paraphenylene-terephthalamide) fibres.
- 5 45. Tire according to claim 43 or 44, wherein said aramid fibres are predispersed in a polymer matrix selected from: natural rubber, butadiene/styrene copolymers, ethylene/vinyl acetate copolymers.
- 10 46. Tire according to claim 45, wherein said polymer matrix is natural rubber.
47. Tire according to claim 42, wherein said discontinuous fibres (g) are selected from: fibres based on other polyamides, on polyesters, on polyolefins, on polyvinyl alcohol; glass fibres; 15 natural fibres such as cellulose, lignine; or mixtures thereof.
- ~~48. Tire according to any one of claims 42 to 47,~~ wherein said discontinuous fibres (g) are present in the crosslinkable elastomeric composition in an amount of from 0 phr to 10 phr.
- 20 49. Tire according to claim 48, wherein said discontinuous fibres (g) are present in an amount of from 0.5 phr to 6 phr.
50. Tire according to any one of the preceding claims, 25 wherein at least one additional reinforcing filler is present in said crosslinkable elastomeric composition in an amount of from 0 phr to 120 phr.
51. Tire according to claim 50, wherein said additional reinforcing filler is silica.
- 30 52. Tire according to claim 51, wherein at least one further silane coupling agent (d) according to claim 39 is present.
53. Crosslinkable elastomeric composition comprising:
- 35 (a) at least one diene elastomeric polymer;
- (b) from 1 phr to 50 phr of at least one layered material having an individual layer thickness



of from 0.01 nm to 30 nm.

(c) from 0.1 phr to 15 phr of at least one methylene donor compound;

(d) from 0.4 phr to 20 phr of at least one methylene acceptor compound.

54. Crosslinkable elastomeric composition according to claim 53, comprising from 2 phr to 40 phr, preferably from 5 phr to 30 phr, of at least one layered material (b).
55. Crosslinkable elastomeric composition according to claim 53 or 54, wherein said at least one layered material (b) has an individual layer thickness of from 0.05 nm to 15 nm.
56. Crosslinkable elastomeric composition according to any one of claims 53 to 55, wherein said crosslinkable elastomeric composition comprises from 0.3 phr to 10 phr of at least one methylene donor compound (c).
57. Crosslinkable elastomeric composition according to any one of claims 53 to 56, wherein said crosslinkable elastomeric composition comprises from 0.8 phr to 15 phr of at least one methylene acceptor compound (d).
58. Crosslinkable elastomeric composition according to any one of claims 53 to 57, wherein said diene elastomeric polymer (a) is defined according to any one of claims 20 to 23.
59. Crosslinkable elastomeric composition according to any one of claims 53 to 58, further comprising at least one elastomeric polymer (a') which is defined according to claim 24 or 25.
60. Crosslinkable elastomeric composition according to claim 58 or 59, wherein the diene elastomeric polymer (a) or the elastomeric polymer (a') include at least one functional group selected from carboxylic groups, carboxylate groups, anhydride

groups, ester groups, epoxy groups.

- 5 61. Crosslinkable elastomeric composition according to any one of claims 53 to 60, wherein said layered material is defined according to any one of claims 27 to 30.
62. Crosslinkable elastomeric composition according to any one of claims 53 to 61, wherein said methylene donor compound (c) is defined according to claim 31 or 32.
- 10 63. Crosslinkable elastomeric composition according to any one of claims 53 to 62, wherein said methylene donor-acceptor (d) is defined according to claims 33 or 34.
- 15 64. Crosslinkable elastomeric composition according to any one of claims 53 to 63, wherein said methylene donor compound (c) and said methylene acceptor compound (d) are added in the precondensed form.
- 20 65. Crosslinkable elastomeric composition according to any one of claims 53 to 64, wherein said crosslinkable elastomeric composition comprises at least one carbon black defined according to claim 36 or 37.
- 25 66. Crosslinkable elastomeric composition according to any one of claims 53 to 65, wherein said crosslinkable elastomeric composition comprises at least one silane coupling agent (f) defined according to any one of claims 39 to 41.
- 30 67. Crosslinkable elastomeric composition according to any one of claims 53 to 66, wherein at least one additional reinforcing filler is present in an amount of from 0 phr to 120 phr.
68. Crosslinkable elastomeric composition according to claim 67, wherein the additional reinforcing filler is silica.
- 35 69. Crosslinkable elastomeric composition according to claim 68, wherein at least one silane coupling

agent (f) defined according to any one of claims 39 to 41 is present.

5 70. Crosslinkable elastomeric composition according to any one of claims 53 to 69, further comprising discontinuous fibres (g) defined according to any one of claims 43 to 49.

10 71. Crosslinked manufactured article obtained by crosslinking a crosslinkable elastomeric composition defined according to any one of claims 53 to 70.

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